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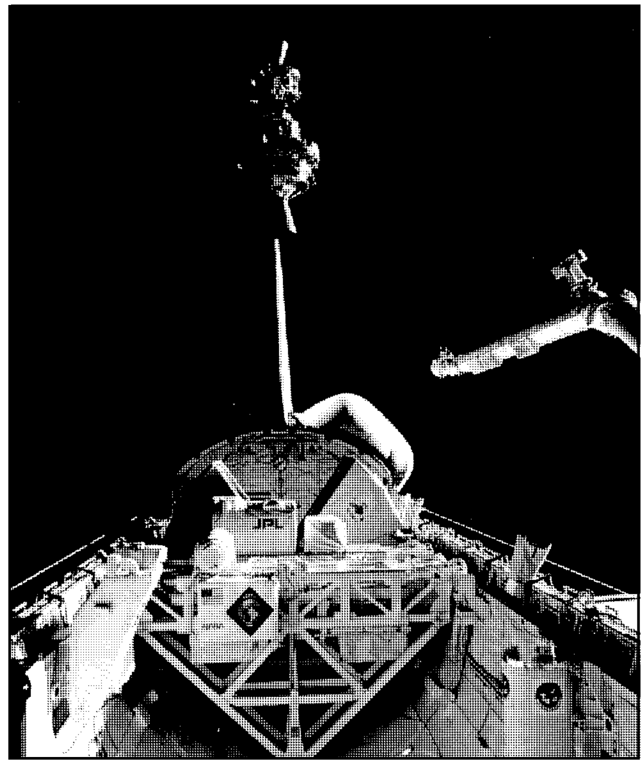
Mission Highlights STS-52

Space Shuttle *Columbia*

October 22 - November 1, 1992

Commander:
James D. Wetherbee (CDR, USN)
Pilot:
Michael A. Baker (CAPT, USN)
Mission Specialists:
William M. Shepherd (CAPT, USN)
Tamara E. Jernigan (Ph.D.)
Charles L. Veach
Payload Specialist:
Steven G. MacLean (Ph.D.)



The Laser Geodynamics Satellite is deployed from the cargo bay of Columbia beginning its journey to a 5,900 km orbit.

Major Mission Accomplishments

- Successfully deployed the second Laser Geodynamics Satellite.
- Conducted 8 payload bay experiments, 10 middeck experiments, 6 developmental test objectives and 12 detailed supplementary objectives.
- Flew first cooperative mission between France and the United States to study material solidification.
- Flew the first mission of the United States Microgravity Payload to test a Nobel Prize winning theory on condensed matter physics.
- Operated interactive crystal growth experiments where adjustments to optimize crystal growth were made by the crew with the guidance from scientists on the ground.
- A series of seven Canadian experiments operated by the Canadian payload specialist investigated material science, fluid physics, atmosphere characterization, and the human body's ability to adapt to space flight.
- Successfully operated an experiment which predicts how heat pipes will work on spinning satellites.

At 12:09 P.M. CDT on Thursday, October 22, 1992, the Space Shuttle *Columbia* lifted off the launch pad at the Kennedy Space Center in Florida beginning Shuttle mission STS-52. The one Canadian astronaut and five U.S. astronauts on board spent the next ten days in orbit deploying the second Laser Geodynamics Satellite (LAGEOS II) and working on science experiments.

LAGEOS II, an Italian spherical satellite that weighs 405 kg and is 60 cm in diameter, has 426 retroreflectors, or prisms uniformly distributed over the outer surface of the satellite that reflect light directly back to its source. LAGEOS II is dedicated exclusively to laser ranging. It was successfully deployed on the morning of the second day of the mission by the crew of *Columbia*. Forty-five minutes later, when the satellite reached a safe distance from the orbiter, the first of two solid rocket motors attached to the satellite ignited and sent LAGEOS II on its way to a 52 degree, 5,900 km orbit around the Earth.

STS-52 Crewmembers (bottom row L to R) William M. Shepherd, Steven G. MacLean, Michael Baker, (top row L to R) James D. Wetherbee, Tamara E. Jernigan, Charles L. Veach

The primary objective of LAGEOS II is to provide scientists with an accurate method of monitoring the motion of the Earth's crust. By bouncing short pulses of laser light from a ground laser station off of LAGEOS II and recording the round trip travel time for the light pulse, scientists can accurately determine the location of the laser station. The relative distance between two laser stations, such as those located on either side of a known fault line, can also be accurately measured. By measuring the change in the distance between ground stations, scientists can determine how much the Earth's crust beneath the stations has moved.

After the deployment of LAGEOS II, the crew lowered *Columbia*'s orbit from 302 by 296 km to 287 km by firing the Orbital Maneuvering System (OMS) rocket engines. The orbit was changed to accommodate experiments in the first United States Microgravity Payload (USMP-1) and to increase the number of landing opportunities at the end of the mission. The USMP-1 payload, located in the payload bay of the orbiter, consisted of three experiments: the French Lambda-Point Experiment (LPE), the Materials for the Study of Interesting Phenomena of Solidification on Earth and in Orbit (MEPHISTO), and the Space Acceleration Measurement System (SAMS).

The LPE experiment tested a Nobel Prize winning physics theory which provides a mathematical explanation for the dynamics of matter near transition points (such as liquid to gas). The theory has applications ranging from hurricane dynamics to superconductivity. By eliminating the detrimental effects of gravity and using ultra sensitive thermometers capable of detecting a temperature difference of a billionth of a degree, LPE measured the heat capacity of liquid helium near its Lambda point at approximately 2.177° K. The LPE experiment tested the theory 100 times more accurately than ever before. Because the equipment operated better than expected during the mission, the LPE science team was able to obtain three times more data than they had originally planned.

The MEPHISTO furnace, designed to study the solid-liquid interface of directionally solidified materials, successfully processed three 15 cm long samples of a tin-bismuth metal alloy during the STS-52 mission. On Earth, the buoyancy-induced convection and differences in hydrostatic pressure affect how a material solidifies and masks some of the important underlying processes of solidification. Sensors on the MEPHISTO furnace accurately measured the temperature and shape of the solid-liquid interface and determined how fast the interface was moving through the sample.

The robust design of the MEPHISTO furnace provided scientists with the ability to change their planned operations to study interesting results observed during the mission. Scientists changed the alloy solidification speed to determine the optimum speed for growing perfect crystals and the speed when the solid-liquid interface becomes unstable. By operating this versatile experiment in microgravity, researchers were able to test theories with wide ranging implications to many types of crystal growth.

Scientists performed another special test with the MEPHISTO furnace where the samples were reprocessed during Shuttle maneuvers. This test will show researchers how Shuttle maneuvers and other microgravity disturbances affect crystal growth. This will be valuable to researchers designing future microgravity experiments.

The third experiment on the USMP-1 payload was SAMS which was designed to measure the acceleration environment on the Shuttle. Although this experiment has flown several times on previous missions, this was the first time that it flew mounted in the cargo bay and the first time it downlinked data real time to researchers on the ground. The information downlinked verified that no significant microgravity disturbances occurred while the other USMP experiments were running.

The Canadian payload specialist, Steve MacLean, spent most of his time on *Columbia* operating the investigations that made up the Canadian Experiments (CANEX-2) payload. The first experiment Steve activated was the Queens University Experiment in Liquid Metal Diffusion (QUELD). QUELD is a high temperature furnace that operates in the middeck of the Shuttle and examines the diffusion of bismuth and tin into each other.

The primary CANEX experiment was the Space Vision System (SVS). The SVS was designed to evaluate components for a machine vision system that will improve the determination of the rate of movement and position of objects being remotely manipulated. Because there are very few reference points in space, astronauts have difficulty gauging distances and velocities of objects away from the Shuttle. MacLean employed the Shuttle's Remote Manipulator System (RMS) arm as a part of the experiment. A computer system converted visual inputs from a television camera on the RMS into position and rate data. This enabled MacLean to determine the exact position of the arm without visual inputs. The SVS was evaluated on this flight to determine if it will be useful on future Space Shuttle missions and on Space Station *Freedom*.

Several other CANEX-2 experiments were conducted on STS-52 during the 10 day flight. Material samples were attached to the orbiter's robot arm in an experiment called the Material Exposure in Low Earth Orbit experiment. The samples will be evaluated after the flight to quantify the degradation of the materials caused by exposure to the low Earth orbit atmosphere. The Phase Partitioning in Liquids experiment measured the effects of electric fields on the separation of a solution containing two polymers. In another experiment, the crew measured the light absorption characteristics of the Earth's atmosphere by pointing the Sun Photometer Earth Atmosphere Measurements-2 apparatus at the Sun during sunrise and sunset, and the Moon during moonrise and moonset. The Orbiter Glow-2 experiment provided data on the causes of spacecraft glow. The Space Adaptation Tests and Observations experiment studied the process of the human body's adaptation to space flight.

The LAGEOS, USMP, and CANEX experiments in the payload bay of *Columbia* shared space with three secondary payloads. The Tank Pressure Control Experiment examined methods for regulating the pressure in fluid containers in microgravity by heating and mixing the fluids in tanks. The Attitude Sensor Package tested three new spacecraft attitude sensors that may be used in future spacecraft. The Shuttle Plume Impingement Experiment measured the flux of atomic oxygen and other atmospheric constituents encountered while on orbit.

The Crystals by Vapor Transport Experiment (CVTE), designed by Boeing, operated in the new Middeck Accommodations Rack. CVTE produced large, high quality crystals of cadmium telluride by heating a solid source material to vapor and allowing it to cool slowly.

Another experiment operated on the middeck of *Columbia*, Heat Pipe Performance (HPP), was designed to test the performance characteristics of rotating heat pipes in microgravity. Up until now, heat pipe applications have only been used on non-spinning satellites because researchers were unable to predict how the heat pipes would operate while spinning in microgravity. With the data collected on HPP, spacecraft designers will be able to use the lighter, more efficient heat pipes on spin-stabilized satellites.

The middeck of Columbia played host to several other experiments during STS-52. The Commercial Materials Dispersion Apparatus Instrumentation Technology Associates Experiment consists of approximately 300 separate experiments including: protein crystal growth, cell research, and seed germination, among others. The Physiological System Experiment-2 evaluated a compound being developed to treat osteoporosis by testing its ability to slow or stop microgravity induced bone loss in rats. Many of the protein crystals grown in the Commercial Protein Crystal Growth II (CPCG) experiment were bigger than those grown on Earth. A sample of alpha interferon flown in CPCG resulted in a crystal more than twice the size of any alpha interferon crystal grown on Earth.

Columbia's crew participated in an interactive question and answer session with the crew of the Polynesian sailing ship *Hokule'a* and school children located at the University of Hawaii. The sailing ship is a replica of the ocean voyaging sailing canoes used by the Polynesians to explore, populate, and trade across the Pacific Ocean.

Crewmember William M. Shepherd works on the Crystals by Vapor Transport Experiment in *Columbia*'s middeck.

Mission Facts

Orbiter: *Columbia*
Mission Dates: October 22 - November 1, 1992
Commander: James D. Wetherbee (CDR, USN)
Pilot: Michael A. Baker (CAPT, USN)
Mission Specialist: William M. Shepherd (CAPT, USN)
Mission Specialist: Tamara E. Jernigan (Ph.D.)
Mission Specialist: Charles L. Veach
Payload Specialist: Steven G. MacLean (Ph.D.)
Mission Duration: 9 days 20 hours 57 minutes
Kilometers Traveled: 6,643,606 km
Orbit Inclination: 28.5 degrees
Orbits of Earth: 159
Orbital Altitude: 296 km
Payload Weight Up: 9,126 kg
Orbiter Landing Weight: 97,780 kg
Landed: Kennedy Space Center Shuttle Landing Facility Runway 33
Payloads and Experiments:
USMP-1 - United States Microgravity Payload 1
LAGEOS II/IRIS
CANEX-2 - Canadian Experiments 2
CPCG - Commercial Protein Crystal Growth
HPP - Heat Pipe Performance
PSE - Physiological Systems Experiment
SPIE - Shuttle Plume Impingement Experiment
CVTE - Crystals by Vapor Transport Experiment
CMIX - Commercial Materials ITA Experiment
ASP - Attitude Sensor Package
TPCE - Tank Pressure Control Experiment
Educational Activities
Question and Answer session with school children located at the University of Hawaii

STS-52 Crew Patch

Crew Biographies

Commander: James D. Wetherbee (CDR, USN)
James Wetherbee was born in Flushing, New York. He earned a bachelor of science degree in aerospace engineering from the University of Notre Dame. After being designated a Naval Aviator, he served aboard the USS John F. Kennedy, where he performed 125 night carrier landings in the A-7E aircraft. While at the Systems Engineering Test Directorate, Wetherbee was a project officer and test pilot for the weapons delivery system and avionics integration of the F/A-18 aircraft. He has logged over 3,500 hours flying time in 20 different types of aircraft. Wetherbee was selected as an astronaut in 1984. He served as pilot on the crew of STS-32.

Pilot: Michael A. Baker (CAPT, USN)
Michael Baker was born in Memphis, Tennessee, but considers Lemoore, California, to be his hometown. He received a bachelor of science degree in aerospace engineering from the University of Texas. After completing flight training, he flew the A-7E aircraft aboard the USS Midway. He conducted A-7 aircraft-related tests on the various aircraft carriers in the Navy's fleet. Baker served as an instructor at the U.S. Naval Test Pilot School before assignment as the U.S. Navy Exchange Instructor at the Empire Test Pilots' School in Boscombe Down, England. He has logged over 4,000 hours flying time in some 50 different types of aircraft, and has completed over 300 carrier landings. He was named an astronaut in 1985, and was pilot of the STS-43 mission.

Mission Specialist: William Shepherd (CAPT, USN)
William Shepherd was born in Oak Ridge, Tennessee, but considers Babylon, New York, his hometown. He earned a bachelor of science degree in aerospace engineering from the U.S. Naval Academy, and the degrees of ocean engineering and master of science in mechanical engineering from the Massachusetts Institute of Technology. He served with the U.S. Navy's Underwater Demolition Team Eleven, SEAL Teams One and Two, and Special Boat Unit Twenty before his selection as an astronaut in 1984. Shepherd has flown two Shuttle missions; as a mission specialist on STS-27 and STS-41.

Mission Specialist: Tamara E. Jernigan (Ph.D.)
Tamara Jernigan was born in Chattanooga, Tennessee. She received a bachelor of science degree in physics (with honors), and a master of science degree in engineering science from Stanford University, a master of science degree in astronomy from the University of California-Berkeley, and a doctorate in space physics and astronomy from Rice University. She worked in the Theoretical Studies Branch at NASA's Ames Research Center, conducting studies of bipolar outflows in the regions of star formation, gamma ray bursters, and shock wave phenomena in the interstellar system. Dr. Jernigan was named an astronaut in 1985. Her assignments have included software verification in the Shuttle Avionics Integration Laboratory and coordinating operations on secondary payloads. She also served as lead astronaut for flight software development. Dr. Jernigan flew as a mission specialist aboard STS-40.

Mission Specialist: Charles Lacy Veach (Mr.)
Lacy Veach was born in Chicago, Illinois, but considers Honolulu, Hawaii, to be his hometown. He earned a bachelor of science degree in engineering management from the U.S. Air Force Academy. After receiving his pilot wings, he attended fighter gunnery school at Luke Air Force Base, Arizona. He served as a U.S. Air Force (USAF) fighter pilot, flying the F-100 Super Sabre, the F-111 and the F-105 Thunderchief on various assignments, including a 275-mission combat tour during the Vietnam War. He has also been a member of the USAF Air Demonstration Squadron, the Thunderbirds. Veach left active duty in 1981 but continues to fly F-16s with the Texas Air National Guard. He has logged over 5,000 flying hours. Named an astronaut in 1984, he flew as a mission specialist aboard STS-39.

Payload Specialist: Steven Glenwood MacLean (Ph.D.)
Steven MacLean was born in Ottawa, Ontario. He earned a bachelor of science degree in honors physics and a doctorate degree in physics from York University. He was a member of Canadian National Gymnastics Team 1 and taught part-time at York University. He became a visiting scholar at Stanford University under Nobel Laureate A. L. Shawlow. Dr. MacLean is a laser physicist whose research has included work on electro-optics, laser-induced florescence of particles and crystals, and multiphoton laser spectroscopy. He was one of six Canadian astronauts selected in 1983. He is astronaut adviser to the Strategic Technologies in the Automation & Robotics Program, and program manager of the Advanced Space Vision System.